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Smart Pump Operation Monitoring and Notification (PuMa) Via Telegram Social Messaging Application

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***Abstract*— Water supply system contains hydraulic components to supply water. The pumps are an important part in water distribution system and need to be well maintained for most of the time. The failure of pump operating system will result in the water shortage inside water tank. This phenomenon might occur due to the tripped pump and power. This paper proposed a remote monitoring and notification system applied in the pump house with the used of Complex Event Processing tools. Whereas, the notification system that act as an output adapter uses a Telegram Social Messaging application. The study is about how fast the notification system between using SMS and Telegram as an output adapter in the pump operation.**

***Keywords*— Telemetry; SCADA; Pump House; Telegram.**

I. INTRODUCTION

The pump house has become a major part in distribution of water over large areas and in water supply system [1]. The subsystem of this facility consists of pumps and equipment which are used to pump water from one place to another. There is a common problem with this kind of subsystem, where the pump might be stopped accidentally due to the power or pump trip, etc. Pumps system are operated for 24 hours to perform water distribution from lower part to the higher part of tanks in the water supply system [2].

The aims of this project are to develop an efficient system on pump house monitoring and to deliver notification efficiently via low cost communication channel (Telegram). Currently, the case studies are located at the pump house that consist of 2 operated pumps.

A. Monitoring System

The realization of such systems would require a system that is capable to deliver the information of pump status in the fastest and simple way. An efficient monitoring system interconnected with a Remote Terminal Unit (CA-RTU™) have been applied in pump house. CA-RTU™ is actually telemetry devices equipped with built-in operating system, Global System for Mobile (GSM) modem, and digital input output (IO) ports [1,2].

A number of studies have shown that modern applications in monitoring water supply have improved the performance in water distribution system. Another research studies about the sensors networks for monitoring water supply and sewer systems deployed at Boston Water and Sewer Commission (BWSC is developing a prototype monitoring system, which bridges advances in wireless sensor networks with advances in hydraulic and water quality modelling. From the study, it has successfully collect and chart near real-time hydraulic and water quality data. The systems produce unique function including sampling rates (up to 1000 S/s), time synchronizations (up to 1ms) and in-network processing. This give a novel opportunity for wirelessly collecting data for applications such as hydraulic pressure transients, remote acoustic leak detection together with low-duty cycle applications such as monitoring water quality parameters and water levels in Combined Sewer Outfalls (CSOs) [3].

Fig. 1 shows a geospatial viewing of sensor data, where any clicked on the map will display details of the sensors including location, value, date, and time. In the other hand, other researchers stated that water distributions infrastructure are increasing in failures and need for real-time monitoring in order to avoid the interruptions of an essential service. The researchers achieved their goals by developing a system which uses a low-cost wireless sensor network which can be applied for high-data-rate, on-line monitoring of hydraulic and water quality parameters within a large urban distribution networks. The remote detection leaks and pipe burst are also achieved and real-time pressure and flow measurements were used to improve state estimation of network [4].

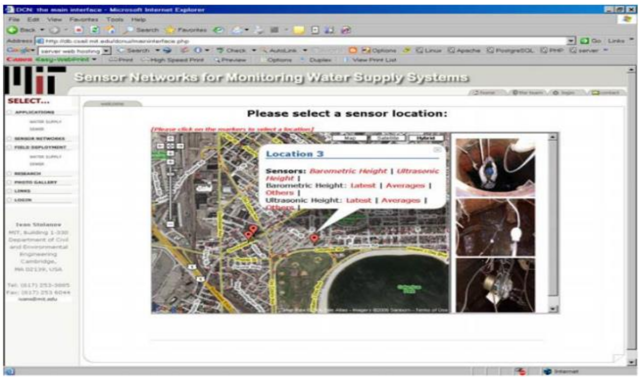

Fig. 1 Web interface including Google MAP API for geospatial viewing of sensor data [3].

B. Notification System, Social Messaging and Unified Messaging

Notification system notifies users when important events occur, or when an event, which requires special attention, occurs. There are lots of the notification systems that have been implemented by previous researchers and developers [5]. It uses Short Messaging Service (SMS) as a notification in fall detection and alerting system. Whereas in other researches uses SMS and Electronic Mail (Email) notification for performance enhancement [6]. The convergence of various communication medium for example, SMS, and social messaging had enabled real time notification of event of interest to users via various measures such as SMS and social messaging tools (i.e. Telegram, Line and WhatsApp).

In this paper, Pump Operation Monitoring and Notification (PuMa) has been developed. Telegram is used as a main communication channel because it is an open source application in social messaging, can communicate between each user (M2M, H2M) efficiently, and at low cost, since messaging by SMS is often more expensive and lack of memory during data transfer. The social messaging such as Telegram, Line, WhatsApp, Viber, etc. are mainstream and very good messaging platforms to be involved in notification and alerting system.

II. Material & Method

A. CAISER™: The Event Processor

With the advance of various communication protocol, it is imperative that the raw events to be detected can be acquired through various communication channels. CAISER™ is a Complex Event Processing (CEP) platform which can be used to develop event processing related applications. It consists of built-in software and hardware adapters, which the user can mix and match to develop other application such as slope monitoring system, network monitoring system and many others.

CAISER™ [21] is a component based CEP development platform suitable for developing CEP systems for Engineering and Scientific application. It is equipped with a set of readily build Event Generator and Event Actuator Adapters (such as OPC Server Adapter, Data Acquisition Board Adapter, Remote Terminal Unit Adapter, Smart CCTV Adapter and Indoor Surveillance Robot Adapter). It is also equipped with numerous Communication Channel Adapter thus enabling it to receive data and relay commands and information via SMS, Email, XMPP and bare TCP/IP. CAISER™ also support inter-components communication via popular social messaging application such as Telegram, Skype, Twitter and Jabber. CAISER™ utilizes several Complex Events detection algorithm to detect Complex Events by fusing previous and current Simple Events information with previously detected Complex Events information. With CAISER™, developing CEP based intelligent engineering and scientific application is as simple as connecting the components and configuring the event detection and mitigation rules

CAISER™ can be used to develop CEP applications to manage and process hundreds of event, alarms, and notifications in business (purchase, payment, fraudulent transaction), scientific Supervisory Control and Data Acquisition (SCADA), Remote Monitoring, engineering (Building Management System, Factory Monitoring, Operation Monitoring), and domestic (home alarm system, community monitoring, elderly monitoring) sector. It can also generate and execute mitigation action automatically for the anomalous event based on user settings and rules.

CAISER™ is fully integrated with adapters, which are suitable to develop engineering and scientific related CEP applications. The event detection algorithm for CAISER™ is both simple to understand and yet powerful enough to enable fusion and correlation of current and past heterogeneous simple and complex events to identify current events and predict future events such that mitigation action can be created immediately and pre-emptively. With CAISER™, CEP application for engineering and scientific purposes can be developed in a matter of minutes.

Events can be conveyed between machine to machine (M2M) or human to machine (H2M) over traditional communication channel and modern protocol (e.g.: TCP/IP, DCOM) and (e.g.: GSM, GPRS, XMPP) respectively. It also can be conveyed using social messaging such as Telegram, Twitter, and Facebook. Table 1 shows list of CAISER™'s adapters.

TABLE I
List Of CAISER's Adapters

#	CAISER™ Adapter	Category
1	CA-DAQ	Input Adapter
2	CA-SMS	Communication Channel (Input/Output)
3	CA-Telegram	Communication Channel (Input/Output)
4	CA-Cloud	Communication Channel (Input)
5	CA-RTM	Event Processor

B. System design

A pump house consists of Remote Terminal Unit (CA-RTU™) interconnected with 4 switches, designated as Pump1, Pump2, Trip1, and Trip2. Two responses will be activated whenever a switch is triggered [7]. First, information is sent to the Web Service (CA-Webservice™) for user interface on the web. Second, information is sent to

Runtime Module (CA-RTM™) server to be analysed and notification is sent automatically to engineering personnel via SMS and Telegram. The PuMa system design is shown as in Fig. 2.

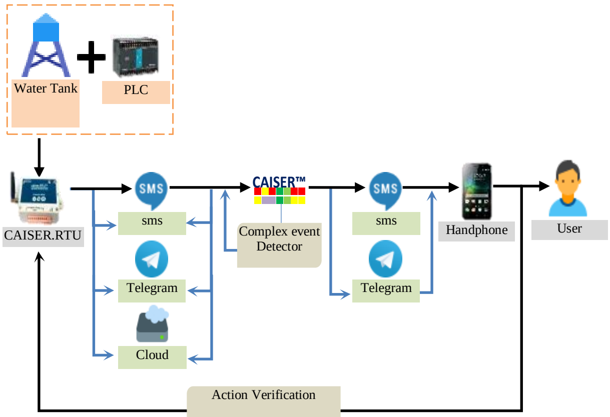

Fig. 2. Topology of Pump Operation Monitoring and Notification (PuMa)

C. Implementation

Based on previous work, a proper monitoring is needed to ensure water sustainability is actually being reached, with disbursement linked to sensing and automation. Such programmatic approach entails microcontroller based automated water level sensing and controlling [8]. PuMa has been implemented in one of UKM's pump house as in Fig. 3(a). Fig. 3 (b) shows switching box of the pump house system, whereas Fig. 3 (c) shows the implementation of CA-RTUTM interconnected to the pump house's relay. Fig. 3 (d) shows the water tank inside pump house. All of these sensors and device are interconnected and integrated with software adapter to produce an efficient monitoring and notification system [9].

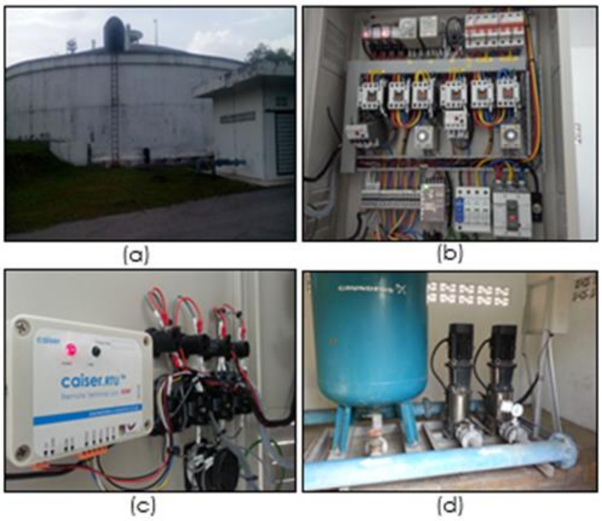

Fig. 3. PuMa Implementation in UKM's Pump House

III. Results And Discussions

A. Web Portal

The UKM pump house monitoring web portal as in Fig. 4 can be reached at ukmpumphouse.caiser.my address. User can monitor the pump status, visualize pump status, and manage nodes.

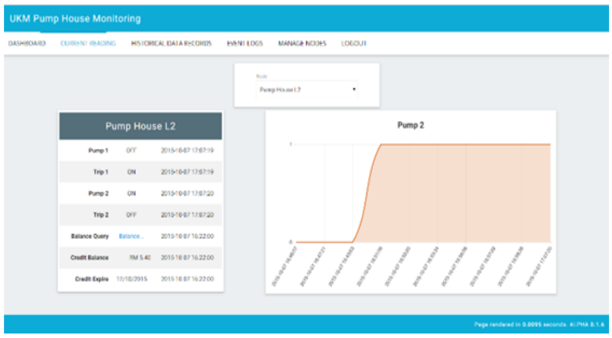

Fig. 4. UKM Pump House Monitoring Web Portal

B. Messaging

Fig. 5 shows the notifications received using Telegram. The important commands created are '`Info.L2`' and '`Help.PUMA`'. '`Info.L2`' request message will retrieve the updated status of each pump in L2 location. Whereas, '`Help.PUMA`' request message will retrieve the specific keyword of PuMa system.

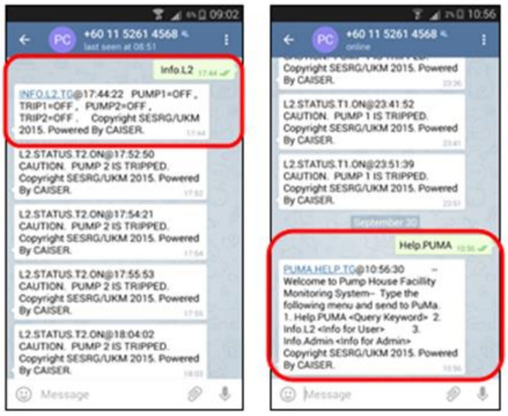

Fig. 5. Command '`Info.L2`' and '`Help.PUMA`' in Telegram Social Messaging

D. Time Latency

Time latency of the system processing is measured starting from time of pump triggered until time of notification received by user.

Fig. 6 shows time taken structure on receiving notification message after pump is triggered. α_1, α_2, and α_3 represents the pump triggered time, message retrieve time at server, and message retrieve time at user respectively. Whereas, T_1 and T_2 represents time taken to reach certain target (Telegram, SMS).

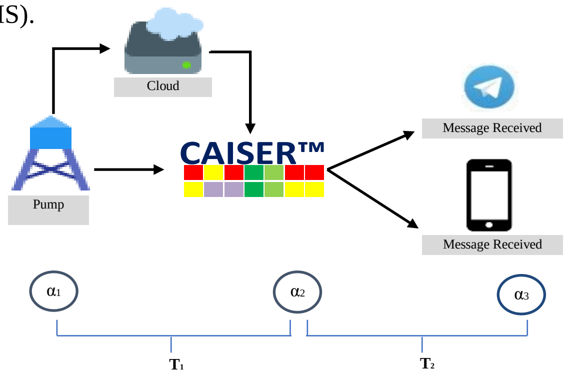

Fig. 6. Time taken to receive the message after pump triggered

Table 2 and Table 3 shows time latency on delivering message after pump triggered. The difference of both Tables is the automatic interval update time. Based on the obtained results, it shows that the notification via Telegram is faster than SMS. Telegram uses Internet data to transfer data, where it is an open source social messaging application.

TABLE II
TIME LATENCY ON DELIVERING MESSAGE AFTER PUMP TRIGGERED (AUTOMATIC INTERVAL UPDATE: 45 SEC)

No	Events	Status	$T_{Total.Telegram}$ (sec)	$T_{Total.SMS}$ (sec)
1	L2.Pump1.Trip1	ON	66	70
2	L2.Pump1.Trip1	ON	70	81
3	L2.Pump1.Trip1	OFF	34	60
4	L2.Pump1.Trip1	OFF	24	88
5	L2.Pump1.Trip1	OFF	59	104

TABLE III
TIME LATENCY ON DELIVERING MESSAGE AFTER PUMP TRIGGERED (AUTOMATIC INTERVAL UPDATE: 5 SEC)

No	Events	Status	$T_{Total.Telegram}$ (sec)	$T_{Total.SMS}$ (sec)
1	L2.Pump1.Trip1	ON	30	45
2	L2.Pump1.Trip1	ON	32	49
3	L2.Pump1.Trip1	OFF	41	101
4	L2.Pump1.Trip1	OFF	38	98
5	L2.Pump1.Trip1	OFF	27	87

IV. CONCLUSIONS

The pump operation and monitoring notification via Telegram is a practical solution and is essential proven in getting the information of the pump status. It is proved that notification via Telegram is much efficient in time compared to SMS due to the protocol involved.

In future, we are planning on having a new notification channel, which is Facebook messenger. We are also planning on directly taking the pump information through our web service due to the stability of the system, which does not involve the credit amount of the Sim Card [10].

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